

RECEIVED
CENTRAL FAX CENTER
APR 26 2007

Verification of Translation

US Patent Application No. 10/798,149

Title of the Invention: NICKEL METAL HYDRIDE STORAGE BATTERY

I, Maki Kusumoto, whose full post office address is IKEUCHI · SATO
& PARTNER PATENT ATTORNEYS, 26th Floor, OAP Tower, 8-30,
Tenmabashi 1-chome, Kita-ku, Osaka-shi, Osaka 530-6026, Japan,

am the translator of the document attached and I state that the following is
a true translation to the best of my knowledge and belief of JP 2003-70776
(Date of Filing: March 14, 2003).

At Osaka, Japan

DATED this 22/2/2006 (Day/Month/Year)

Signature of the translator


Maki KUSUMOTO

**PATENT OFFICE
JAPANESE GOVERNMENT**

This is to certify that the annexed is a true copy of the following application as filed with this Office.

Date of Application: March 14, 2003

Application Number: Patent Application No. JP 2003-070776

Applicant(s): Matsushita Electric Industrial Co., Ltd.
TOYOTA JIDOSHA KABUSHIKI KAISHA

March 4, 2004
Commissioner, Patent Office: Yasuo IMAI

2003-70776

【Document Name】 Patent Application

【Case Number】 2206240132

【Date of Application】 March 14, 2003

【Destination】 Director General of the Japanese Patent Office

【Intern. Patent Classification】 H01M 2/02

【Inventor】

【Address】 c/o PANASONIC EV ENERGY CO., LTD.
555, Sakaijuku, Kosai-shi, Shizuoka

【Name】 Katsunori KOMORI

【Inventor】

【Address】 c/o PANASONIC EV ENERGY CO., LTD.
555, Sakaijuku, Kosai-shi, Shizuoka

【Name】 Yoshiaki OGATA

【Inventor】

【Address】 c/o PANASONIC EV ENERGY CO., LTD.
555, Sakaijuku, Kosai-shi, Shizuoka

【Name】 Atsushi ADACHI

【Inventor】

【Address】 c/o PANASONIC EV ENERGY CO., LTD.
555, Sakaijuku, Kosai-shi, Shizuoka

【Name】 Katsunori MAEKAWA

【Inventor】

【Address】 c/o PANASONIC EV ENERGY CO., LTD.

2003-70776

555, Sakaijuku, Kosai-shi, Shizuoka

[Name] Noriyuki FUJIOKA

[Patent Applicant]

[Identification Number] 000005821

[Name/Title] Matsushita Electric Industrial Co., Ltd.

[Patent Applicant]

[Identification Number] 000003207

[Name/Title] TOYOTA JIDOSHA KABUSHIKI KAISHA

[Attorneys]

[Identification Number] 110000040

[Name/Title] Ikeuchi Sato & Partner Patent Attorneys

[Representative] Hiroyuki IKEUCHI

[Telephone Number] 06-6135-6051

[Indication of Official Fees]

[Deposit Account Number] 139757

[Amount of Deposit] 21000

[List of File Documents]

[Name of Document] Specification 1

[Name of Document] Drawings 1

[Name of Document] Abstract 1

[General Power of Attorney's Number] 0108331

[Proof Required] Yes

2003-70776

[Document Name] Specification

[TITLE OF THE INVENTION]

NICKEL METAL HYDRIDE STORAGE BATTERY

[CLAIMS]

[Claim 1] A nickel metal hydride storage battery, comprising:
a battery case; and
a group of electrode plates arranged in the battery case,
wherein the battery case comprises a battery case main body having
a hole and a lid for closing the hole;

the battery case comprises a first portion made of only a metal or a
laminate of a metal and a resin, and a second portion made of only a resin;
and

an area of the first portion is 20% or more and 90% or less with
respect to the entire battery case.

[Claim 2] The nickel metal hydride storage battery according to claim 1,
wherein the battery case main body comprises a resin case and a
multilayered film formed on a part of the surface of the resin case;

the multilayered film comprises a metal layer and two resin layers
arranged in a manner in which the metal layer is interposed between the two
resin layers; and

a portion on which the multilayered film is formed is the first
portion.

[Claim 3] The nickel metal hydride storage battery according to claim 1,
wherein the average thickness of the second portion is 0.7 mm or
more and 2.5 mm or less; and

the hydrogen permeability coefficient at 40°C of the resin forming
the second portion is 2×10^{-15} mol·m/m²·sec·Pa or more and 1×10^{-14}
mol·m/m²·sec·Pa or less.

[Claim 4] The nickel metal hydride storage battery according to claim 1,
wherein the average value of the hydrogen permeability at 40°C of
the second portion is 1.4×10^{-18} mol/m²·sec·Pa or more and 2.5×10^{-17}
mol/m²·sec·Pa or less.

[Claim 5] The nickel metal hydride storage battery according to claim 1,
wherein the group of electrode plates comprise a negative electrode
comprising a hydrogen absorbing alloy as a main component; and
the hydrogen absorbing alloy has an equilibrium hydrogen
desorption pressure at 45°C of 0.02 MPa or more and 0.1 MPa or less.

2003-70776

[Claim 6] The nickel metal hydride storage battery according to any of claims 1 to 5,

wherein the second portion comprises a polymer alloy of polypropylene and polyphenylene ether.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[Technical field to which the invention pertains]

The present invention relates to nickel metal hydride storage batteries.

[0002]

[Prior Art]

For a battery case of an enclosed nickel metal hydride storage battery, a resin battery case or a metal battery case is used. Furthermore, a resin battery case whose surface is coated with a metal layer has been proposed (see, for example, Patent Document 1).

[0003]

An enclosed nickel metal hydride storage battery is designed so that the capacity of the negative electrode is larger than the capacity of the positive electrode. Excess capacity that can be charged of the negative electrode is referred to as "charge reserve," and excess capacity of the negative electrode that can be discharged is referred to as "discharge reserve." The discharge capacity of the battery is limited by the capacity of the positive electrode (positive electrode regulation). By making the negative electrode capacity larger than the positive electrode capacity, it is possible to suppress the increase in the internal pressure at the time of overcharging and overdischarging.

[0004]

In a nickel metal hydride storage battery using a resin battery case, a small amount of hydrogen continues to leak out through the battery case. If hydrogen leaks out from the battery, the discharge reserve at the negative electrode is decreased in accordance with the amount of leaked hydrogen. Therefore, in the nickel metal hydride storage battery that was used for a long time, the capacity balance between the positive electrode and the negative electrode is lost and the negative electrode capacity is decreased. As a result, the discharge capacity may be decreased or oxygen may be generated from the negative electrode at the time of overdischarging. Thus, it is thought that in such a nickel metal hydride storage battery using a resin

2003-70776

battery case, a so-called long-term deterioration occurs that appears when a small amount of hydrogen continues to leak out for a long time. Since hydrogen leaks out very slowly, it does not matter during a general using term. However, this deterioration may matter in batteries that are intended to be used for a long time, for example, batteries that are required to have 10 years or more of life.

[0005]

[Patent Document 1]

The specification of Japanese Patent No. 3049854

[0006]

[Problems to be solved by the invention]

On the other hand, in a metal battery case or a resin battery case coated with a metal layer, since hydrogen is not likely to permeate the battery case, the above-mentioned deterioration is not likely to occur. However, in the nickel metal hydride storage battery, regardless of materials of the battery case, a hydrogen-absorbing alloy at the negative electrode is corroded and a side reaction occurs in which the amount of hydrogen to be absorbed by the hydrogen-absorbing alloy is increased. As a result, the discharge reserve at the negative electrode is increased while the charge reserve at the negative electrode is decreased and thus the internal pressure of the battery is increased easily at the time of charging. When the charge reserve continues to be decreased due to a long period of use, the internal pressure of the battery becomes too high at the time of full charging and the safety valve operates. As a result, gas or electrolyte inside the battery is released, which may deteriorate the property of the battery considerably. Thus, it is thought that in the nickel metal hydride storage battery, regardless of materials of the battery case, long-term deterioration may occur due to the corrosion of the hydrogen absorbing alloy after it is used for a long time.

[0007]

It is an object of the present invention to provide a nickel metal hydride storage battery capable of suppressing the long-term deterioration by controlling the amount of hydrogen permeating a battery case.

[0008]

[Means for solving the problems]

In order to achieve the above-described object, the storage battery of the present invention includes a battery case; and a group of electrode plates arranged in the battery case. The battery case includes a battery case main

2003-70776

body having a hole and a lid for closing the hole; the battery case includes a first portion made of only a metal or a laminate of a metal and a resin, and a second portion made of only a resin; and an area of the first portion is 20% or more and 90% or less with respect to the entire battery case. Herein, an area of the entire battery case, an area of the first portion and an area of the second portion denote an area associated with the leakage of hydrogen inside the battery case and do not include an area that increases by convex/concave portions formed on the surface thereof. The area herein is an area that is approximated to a smooth surface.

[0009]

In the nickel metal hydride storage battery, the battery case main body may include a resin case and a multilayered film formed on a part of the surface of the resin case. The multilayered film includes a metal layer and two resin layers arranged in a manner in which the metal layer is interposed between the two resin layers; and a portion on which the multilayered film is formed is the first portion.

[0010]

In the nickel metal hydride storage battery, the average thickness of the second portion may be 0.7 mm or more and 2.5 mm or less. The hydrogen permeability coefficient at 40°C of the resin forming the second portion is 2×10^{-15} mol·m/m²·sec·Pa or more and 1×10^{-14} mol·m/m²·sec·Pa or less. Note here that the values of the hydrogen permeability coefficient and hydrogen permeability described herein are values measured at the temperature of 40°C based on the method defined in JIS-K7126 A.

[0011]

In the above-mentioned nickel metal hydride storage battery, the group of electrode plates may include a negative electrode including a hydrogen absorbing alloy as a main component and the equilibrium hydrogen desorption pressure of the hydrogen absorbing alloy at 45°C may be 0.02 MPa or more and 0.1 MPa or less.

[0012]

In the above-mentioned nickel metal hydride storage battery, the second portion may be formed of a polymer alloy of polypropylene and polyphenylene ether.

[0013]

[Mode for carrying out the invention]

Hereinafter, the present invention will be explained by way of

2003-70776

embodiments. Fig. 1(a) shows a top plan view of a nickel metal hydride storage battery 10 (hereinafter, also referred to as a battery 10) that is one example of the battery of the present invention, and Fig. 1(b) is a side view thereof.

[0014]

The battery 10 is provided with a battery case 12 including a group of electrode plates 20 arranged therein. The battery case 12 includes a battery case main body 11 having holes and a lid 11a enclosing the holes of the battery case main body 11. A safety valve 13, a lid 14 of a communication hole and a temperature sensor mounting hole 15 are arranged in the lid 11a. Two terminals 16 are provided in the battery case main body 11. The safety valve 13 opens when the internal pressure in the battery case 12 reaches a predetermined value or more, and the gas inside is released so as to reduce the internal pressure in the battery case 12. A plurality of protrusions are formed on the surface of the battery case main body 11 in order to improve the heat radiation property when a plurality of nickel metal hydride storage batteries 10 are arranged while being attached tightly to each other. Fig. 2 is a partial cross-sectional view taken on line I-I of Fig. 1(a).

[0015]

The inside of the battery case main body 11 is partitioned into six compartments by partitions 11b. A group of electrode plates 20 and electrolyte (not shown) are disposed in each compartment. The group of electrode plates 20 and the electrolyte constitute a cell 17. In other words, the nickel metal hydride storage battery 10 includes six cells 17. The lid 14 equalizes the internal pressures in the cells 17.

[0016]

Fig. 3 is a cross-sectional view showing a group of electrode plates 20. The group of electrode plates 20 includes a separator 21, a positive electrode plate 22 and a negative electrode plate 23 that are laminated alternately with the separator 21 interposed therebetween, a collector 24 connected to the positive electrode plate 22 and a collector 25 connected to the negative electrode plate 23. As shown in Fig. 2, the collectors 24 and 25 are connected to the terminal 16 or a connection terminal 26. The collector 25 of the cell 17 is connected to the collector 24 of the adjacent cell 17 via the connection terminal 26. Thus, the cells 17 are connected in series.

[0017]

2003-70776

For the group of electrode plates 20 and electrolyte, those generally used for nickel metal hydride storage batteries can be used. For an electrolyte, for example, an aqueous solution having a specific gravity of about 1.3 that contains potassium hydroxide or lithium hydroxide as a solute can be used. For the separator 21, for example, a polypropylene nonwoven fabric that was made to be hydrophilic can be used. The positive electrode plate 22 can be produced by applying a paste containing nickel hydroxide as an active material to a conductive support member so as to produce a sheet, and then drying, rolling and cutting this sheet.

[0018]

On the other hand, the negative electrode plate 23 can be produced by applying a paste containing a hydrogen-absorbing alloy to a conductive support member so as to produce a sheet, and then drying, rolling and cutting this sheet. It is preferable that the hydrogen absorbing alloy used for the negative electrode 23 has an equilibrium hydrogen desorption pressure at 45°C of 0.02 MPa or more and 0.1 MPa or less. By setting the value of the equilibrium hydrogen desorption pressure in this range, it is possible to avoid the deterioration of the discharging property due to the low equilibrium hydrogen desorption pressure and the deterioration of the charging property due to the high equilibrium hydrogen desorption pressure.

[0019]

The following is an explanation of the battery case 12. The battery case 12 includes a first portion made of only a metal or a laminate of a metal and a resin, and a second portion made of only a resin. The area of the first portion is in the ratio of 20% or more and 90% or less (preferably, 40% or more and 80% or less, and more preferably in the range from 50% or more and 70% or less) with respect to the entire area of the battery case 12. The portion other than the first portion is a second portion except for only a portion such as a portion provided with a safety valve. That is to say, the battery case 12 substantially includes the first portion and the second portion.

[0020]

Hydrogen is likely to permeate the second portion as compared with the first portion. It is preferable that the hydrogen permeability coefficient at 40°C of the resin constituting the second portion is 2×10^{-15} mol·m/m²·sec·Pa or more and 1×10^{-14} mol·m/m²·sec·Pa or less. An example of the resin constituting the second portion includes a polypropylene (PP)

2003-70776

single substance, a polymer alloy of polystyrene (PS) and polyphenylene ether (PPE), or a polymer alloy of polypropylene (PP) and polyphenylene ether (PPE). When the polymer alloy is used, it is possible to control the hydrogen permeability coefficient by changing the mixing ratio. The average thickness of the second portion is 0.7 mm or more and 2.5 mm or less. It is preferable that the average value of the hydrogen permeability at 40°C of the second portion is 1.4×10^{-18} mol/m²·sec·Pa or more and 2.5×10^{-17} mol/m²·sec·Pa or less.

[0021]

Since the first portion includes a metal layer, no hydrogen permeability is observed when tested in accordance with JIS-K 7126 A method as mentioned above.

[0022]

The battery case 12 including the first portion and the second portion can be achieved by various embodiments. Some of the examples are explained hereinafter.

[0023]

A battery case main body 11 of the first embodiment includes a resin case and a multilayered film formed on a part of the surface of the resin case. The multilayered film includes at least one metal layer, for example, two resin layers with a metal layer interposed therebetween. Such a battery case main body can be formed by inserting a multilayered film into a part of the resin case (for example, an entire longitudinal side surface). A lid may be formed of a resin, or the multilayered film may be formed on a lid formed of a resin. A part of the battery case 12 on which the multilayered film is formed is the first portion and a part in which the multilayered film is not formed is the second portion. Therefore, in the area of the entire battery case 12 including the lid, the area of the portion in which the multilayered film is formed is 20% or more and 90% or less. As an example, Fig. 4 is a partial cross-sectional view showing a battery case main body having the outer surface of the resin case on which the multilayered film is formed.

[0024]

With reference to Fig. 4, the battery case main body 41 includes a resin case 42 and a multilayered film 43 formed on a part (for example, a longitudinal side surface) of the outer surface of the resin case 42. The resin case 42 is a case made of a resin or a case containing a resin as a main component. As the thickness of the resin case 42 is increased, the strength

2003-70776

is increased and gas permeability is lowered. However, the mass increases. Furthermore, as the thickness of the resin case 42 is increased, the heat radiation property of the battery is deteriorated. Therefore, it is preferable that the average thickness of the resin case 42 is 0.7 mm or more and 2.5 mm or less.

[0025]

The resin case 42 can be formed of a resin as described above, namely, a PP single substance or a polymer alloy of PP and PPE. The multilayered film 43 includes a metal foil 43b and resin layers 43a and 43c with the metal foil 43b interposed therebetween. As the metal foil 43b, for example, an Al foil can be used. It is preferable that the resin layer 43a includes the same resin as the resin constituting the resin case 42. The resin layers 43a and 43b can be formed by polypropylene (PP), etc. Note here that the multilayered film shown in Fig. 4 is one example, and a multilayered film of another type can be used as long as it includes a metal layer and can achieve the object of the present invention.

[0026]

In the second embodiment, an entire battery case is the first portion and the lid is the second portion. In this embodiment, the battery case main body is made of a metal, or the multilayered film 43 or a metal film is formed on the entire resin case 42. When the battery case main body is made of a metal, the battery case main body can be produced by, for example, a Ni-plating steel sheet.

[0027]

It is particularly preferable that the nickel metal hydride storage battery of the present invention is in an application that is intended to be used for a long time. For example, it is preferable that the battery of the present invention is used as a power supply for electric cars and hybrid cars. The capacity of the battery of the present invention in such an application is made to be about, for example, 4 Ah to 10 Ah. In the case of the rectangular shaped battery used for such an application, the surface area that is calculated by approximating the battery to a rectangular parallelepiped, that is, a surface area per single cell calculated from the external size (length, width and height) of the battery is generally about 100 cm² to 300 cm².

[0028]

When the nickel metal hydride storage battery using a resin battery case is used for a long time, since a small amount of hydrogen continues to

2003-70776

leak out, the amount of the discharge reserve of the negative electrode is decreased. On the other hand, by the corrosion of the hydrogen absorption alloy at the negative electrode, the amount of the charge reserve is decreased. In the case of the battery case made of only a resin, the decrease in the amount of discharge reserve is significantly larger than the decrease in the amount of the charge reserve, and the capacity of the negative electrode is decreased. On the contrary, in the battery case made of only a metal, the decrease in the amount of charge reserve is significantly larger than the decrease in the amount of the discharge reserve, and the internal pressure of the battery is likely to be increased. On the other hand, the battery case of the nickel metal hydride storage battery of the present invention includes an amount rate of the second portion in which hydrogen is likely to permeate. Therefore, it is thought that the balance between the decrease in the amount of the discharge reserve due to the leakage of hydrogen and the decrease in the amount of the charge reserve due to the corrosion of the hydrogen absorbing alloy is not significantly altered. As a result, it is thought that according to the nickel metal hydride storage battery of the present invention, the deterioration of the properties after a long period of use can be suppressed.

[0029]

[Examples]

Hereinafter, the present invention will be explained in more detail by way of Examples.

[0030]

(Example 1)

In Example 1, a plurality of nickel metal hydride storage batteries having different battery cases respectively were produced and the properties thereof were evaluated. First of all, the method for producing the respective batteries will be explained. Note here that the batteries in Example 1 were designed and produced so that the capacity of the positive electrode was 6.5 Ah and the capacity of the negative electrode was 10 Ah.

[0031]

(Comparative Sample 1)

In the comparative sample 1, a conventional resin battery case was used. Specifically, a battery case (average thickness: 1.5 mm) made of a polymer alloy of PP and PPE and formed by injection molding was used. The hydrogen permeability coefficient of this polymer alloy was 4×10^{-15}

2003-70776

mol·m/m²·sec·Pa.

[0032]

For a separator, a sulfonated polypropylene non-woven fabric was used. For the positive electrode plate, a positive electrode plate containing nickel hydroxide was used; and for the negative electrode plate, a negative electrode plate containing a hydrogen-absorbing alloy was used. For an electrolyte, an alkaline aqueous solution having a specific gravity of about 1.3 that contains potassium hydroxide as a main solute was used. By using these members, the nickel metal hydride storage battery having a configuration shown in Figs. 1 to 3 (comparative sample 1) was produced.

[0033]

(Comparative Sample 2)

In the comparative sample 2, a battery case whose entire surface was coated with an Al-evaporation film was used. Specifically, a battery case obtained by depositing Al on the entire surface of the resin battery case used in the comparative sample 1 was used. The same battery (comparative sample 2) was produced as the battery of the comparative sample 1 except that the battery case was different.

[0034]

(Sample 1)

In sample 1, a battery case was used in which only an entire longitudinal side surface of the battery main body made of a resin (excluding a lid) was coated with an Al-evaporation film. For the battery case main body made of a resin, the same battery case main body as that used in the comparative sample 1 was used. An area coated with the Al-evaporation film was made to be 70% with respect to the entire area (a total area of the top surface, a bottom surface and a side surface) of the battery case. The battery (sample 1) that was the same as the battery of the comparative sample 1 except that the battery case was different was produced.

[0035]

(Sample 2)

In sample 2, a battery case in which an Al laminated sheet was inserted and formed on a longitudinal side surface portion of the battery case main body (excluding a lid) made of a resin was used. For the laminate sheet, a sheet made of an Al foil (thickness: 50 μ m) sandwiched by two PP layers (thickness: 20 μ m) was used. An area of the portion on which a laminate sheet was formed was made to be 70% with respect to the entire

2003-70776

area of the battery case. The same battery (sample 2) was produced as the battery of the comparative sample 1 except that the battery case was different.

[0036]

(Sample 3)

In sample 3, a battery case in which a longitudinal side surface portion of the battery case main body (excluding a lid) made of resin was Ni-plated was used. An area of the Ni-plated portion was made to be 70% with respect to the entire battery case. The same battery (sample 3) was produced as the battery of the comparative sample 1 except that the battery case was different.

[0037]

A plurality of the above-mentioned five kinds of samples were formed respectively. These batteries were charged so that the state of charge (SOC) was 80% and then stored in an atmosphere at 65°C for 1 month to 3 months. Then, the amount of the discharge reserve of the negative electrode was measured before it was stored, stored for one month, two months, and three months, respectively.

[0038]

The amount of the discharge reserve was measured by the following method. First, the battery was discharged until the voltage of the battery reached 1.0 V. Then, a hole was provided on the upper portion of the battery and an electrolyte was refilled so that excessive electrolyte was present. Then, a Hg/HgO reference electrode was immersed in the electrolyte in the battery case. Then, the battery was overdischarged while the discharge capacity was measured. The amount of discharge reserve was defined by an equation: (the amount of discharge reserve) = (the discharge capacity up to the point when the potential difference of the negative electrode with respect to the reference electrode reaches -0.7 V) - (the discharge capacity up to the point when the potential difference of the positive electrode with respect to the reference electrode reaches -0.5 V). Table 1 shows the measurement results of the amount of discharge reserve.

2003-70776

[0039]

[Table 1]

	Amount of discharge reserve [Ah]			
	Initial value	Stored for 1 month	Stored for 2 months	Stored for 3 months
Comparative sample 1	2.5	2.4	1.9	1.3
Comparative sample 2	2.5	3.2	3.6	3.9
Sample 1	2.5	2.8	2.8	2.7
Sample 2	2.5	3.0	2.9	2.8
Sample 3	2.5	2.8	2.6	2.4

As shown in Table 1, in the comparative sample 1, the discharge reserve was decreased and the deterioration mode proceeded, which may lead to the negative electrode regulation. In the comparative sample 2, the discharge reserve was increased, that is, the charge reserve was decreased and the deterioration mode proceeded so as to open the safety valve. On the other hand, in the samples 1 to 3, the above-mentioned two deterioration modes did not proceed, thus enabling the deterioration to be suppressed.

[0040]

(Example 2)

In Example 2, a battery was produced by using a battery case formed by insert-molding a laminate sheet described with respect to the sample 2 to a part of the resin battery case, and then the property thereof was evaluated. For the resin battery cases, four kinds of battery cases each having different hydrogen permeability coefficient and average thickness were used. The battery case was formed of a polymer alloy of PP and PPE, and by altering the mixing ratio of PP and PPE, the hydrogen permeability coefficient of the polymer alloy was made to be 2×10^{-15} mol·m/m²·sec·Pa or 1×10^{-14} mol·m/m²·sec·Pa. The areas of the portion for the laminate sheets to be formed were made to be 20%, 60% and 90%, respectively. Furthermore, as a comparative example, a battery case that was not coated with a laminate sheet also was prepared. Note here that when the battery case was coated with a laminate sheet, insertion molding was carried out so that the areas that coat the respective cells arranged in the battery case are the same.

[0041]

By using the above-mentioned battery cases, the nickel metal

2003-70776

hydride storage batteries were produced by the same method as in the comparative sample 1. However, in Example 2, a hydrogen absorbing alloy having equilibrium hydrogen desorption pressure at 45°C of 0.02 MPa or 0.1 MPa was used.

[0042]

The thus obtained batteries were charged so that SOC became 80% and stored in the atmosphere of 65°C for three months. Then, as to the stored batteries, the amount of discharge reserve of the negative electrode was measured by the same method as in Example 1. Table 2 shows the measurement results.

[0043]

[Table 2]

Hydrogen permeability coefficient at 40°C of battery case resin [mol · m/m ² · sec · Pa]	Average thickness of battery case [mm]	Equilibrium hydrogen desorption pressure of alloy [MPa]	Amount of discharge reserve after stored for 3 months [Ah]			
			Not coated	20% coated	60% coated	90% coated
1×10^{-14}	0.7	0.10	-	-	-0.8	2.4
		0.02	0.3	1.0	2.2	3.2
	2.5	0.10	-0.2	0.5	2.0	3.1
		0.02	2.4	2.6	3.1	3.4
2×10^{-15}	0.7	0.10	-0.3	0.5	2.0	3.1
		0.02	2.4	2.6	3.1	3.4
	2.5	0.10	2.2	2.5	3.0	3.4
		0.02	3.1	3.2	3.4	3.5

Note here that the amount of discharge reserve in Table 2 was calculated from the equation defined in Example 1. Batteries whose amount of discharge reserve in Table 2 is shown by a minus value are batteries of negative electrode regulation. The amount of discharge reserve was 2.5 Ah.

[0044]

The amount of hydrogen permeating the battery case is changed depending upon the hydrogen permeability coefficient of a resin constituting the battery case, thickness of the battery case, equilibrium hydrogen desorption pressure of the hydrogen absorbing alloy, and the like. However, by optimizing the area coated with the metal layer with respect to the entire

2003-70776

area of the battery case in the range from 20% to 90%, the amount of discharge reserve could be maintained at approximately the initial value.

[0045]

In the batteries of the present invention, the area in which the metal layer is formed is optimized by taking the condition for use (environment temperature, charge and discharge current value, charge and discharge depth, charge and discharge frequency, etc.) into account, and a battery having little deterioration can be obtained. In Examples, battery cases made of a polymer alloy of PP and PPE, which is excellent in the strength, heat resistance, chemical resistance, and weldability, were used. However, even if batteries made of other resin materials are used, the same effects as those of the present invention can be obtained. Furthermore, in Examples, the case where a metal layer is formed in a part of the surface of the battery case was explained. The same effect as that of the present invention can be obtained in the case of using a battery case including a battery case main body made of a metal and a hole enclosing plate, part of which was made of only a resin was used. Furthermore, in the Examples, a rectangular shaped battery was described but the battery of the present invention is not limited to this alone.

[0046]

The foregoing described the embodiments of the present invention by way of the Examples. However, the present invention is not limited to the above-described embodiments and can be applied to other embodiments based on the technical thought of the present invention.

[0047]

[Effects of the invention]

As discussed above, according to the present invention, it is possible to obtain a nickel metal hydride storage battery that is hardly deteriorated after a long period of use. The present invention is particularly suitable for batteries that are intended to be used for a long period, for example, used as batteries for a power supply of electric cars or hybrid cars.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[Fig. 1]

Fig. 1(a) is a top plan view showing an example of an alkali storage battery according to the present invention, and Fig. 1(b) is a side view thereof.

[Fig. 2]

Fig. 2 is a partial cross-sectional view showing the alkali storage

2003-70776

battery shown in Fig. 1.

[Fig. 3]

Fig. 3 is a cross-sectional view showing a group of electrode plates of the alkali storage battery shown in Fig. 1.

[Fig. 4]

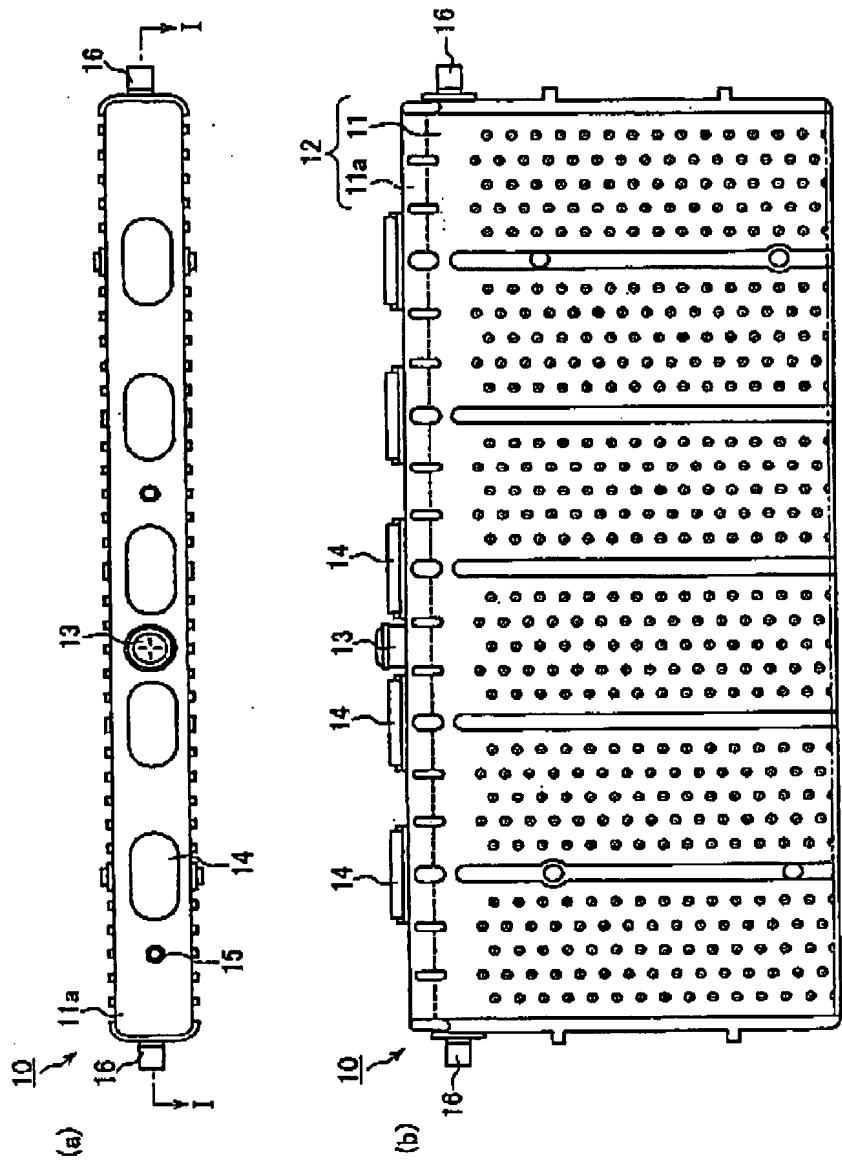
Fig. 4 is a partial cross-sectional view showing an example of a battery case main body of the alkali storage battery according to the present invention.

[Explanation of letters or numerals]

10	Nickel metal hydride storage battery
11,41	Battery case main body
11a	Lid
12	Battery case
13	Safety valve
14	Lid of a communication hole
15	Temperature sensor mounting hole
16	Terminal
17	Cell
20	Group of electrode plates
21	Separator
22	Positive electrode plate
23	Negative electrode plate
24,25	Collector
26	Connection terminal
42	Resin case
43	Multilayered film
43a,43c	Resin layer
43b	Metal foil

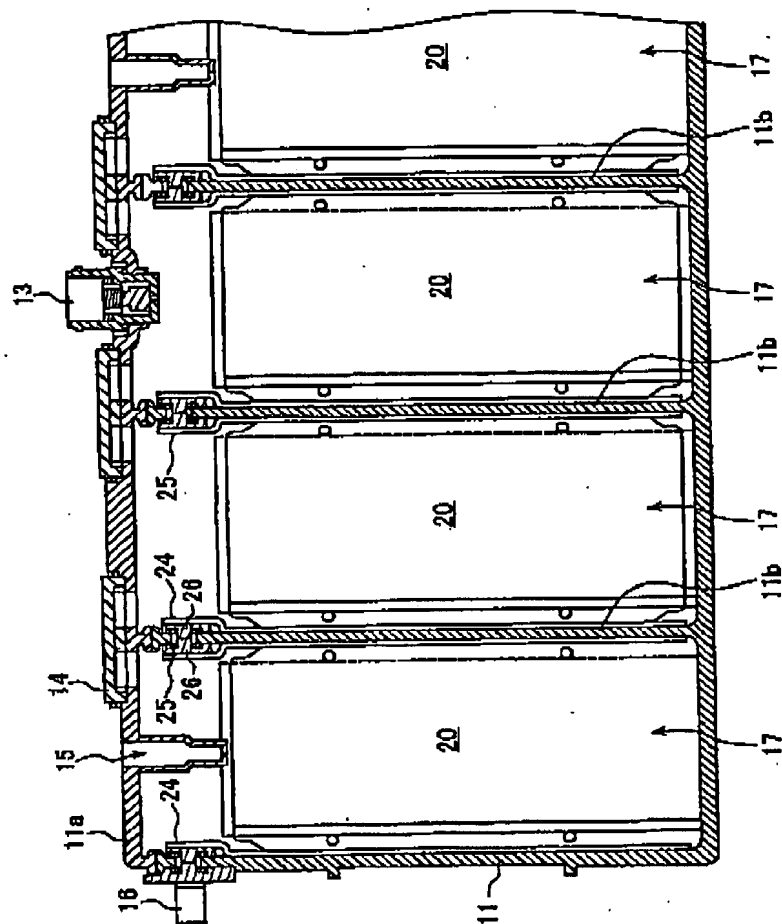
2003-70776

[Document Name] Drawings
[Fig. 1]



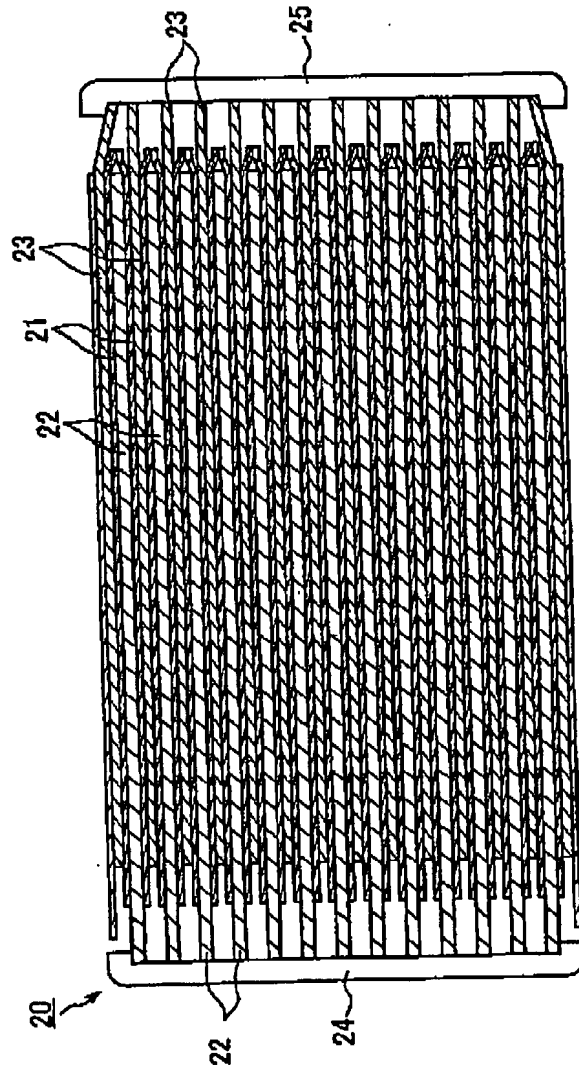
2003-70776

[Fig. 2]



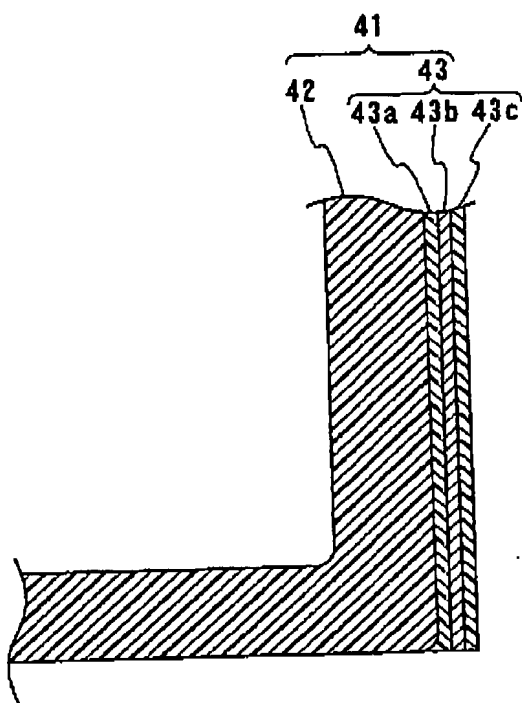
2003-70776

[Fig. 3]



2003-70776

[Fig. 4]



2003-70776

[Document Name] Abstract

[ABSTRACT]

[Object]

A nickel metal hydride storage battery is provided that is capable of controlling the amount of hydrogen permeating a battery case and capable of suppressing the long-term deterioration.

[Means]

A nickel metal hydride storage battery includes a battery case 12, and a group of electrode plates arranged in the battery case, wherein the battery case 12 includes a battery case main body 11 having a hole and a lid 11a for closing the hole. The battery case 12 includes a first portion made of only a metal or a laminate of a metal and a resin, and a second portion made of only a resin. An area of the first portion is 20% or more and 90% or less with respect to the entire battery case. The average thickness of the second portion is 0.7 mm or more and 2.5 mm or less. The hydrogen permeability coefficient at 40°C of the resin forming the second portion is 2×10^{-15} mol·m/m²·sec·Pa or more and 1×10^{-14} mol·m/m²·sec·Pa or less.

[Selected figure] FIG. 1